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CCLIV.—SUGAR-CANE BORERS IN THE WEST INDIES.

During the last few years a considerable correspondence has been carried on between the Royal Gardens, Kew, and the West India Islands, respecting attacks on sugar-canes inflicted by various insects popularly described as "borers." The first of these borers, reported from St. Vincent in 1890, was the caterpillar of a moth known as *Chilo saccharalis* sometimes called *Diatræa saccharalis*. This was first described in 1828 by the Rev. Lansdown Guilding, also from St. Vincent specimens, and there is little doubt that the "moth-borer," to use the name under which it is popularly known, has been present in the West Indies and elsewhere as a pest of sugar-cane for the last hundred years. Of late it has injured sugar-cane crops in Jamaica (1841); in Mauritius (1856); in the Southern United States (1857); and in British Guiana (1879). It has been noticed also in Queensland and more recently in India. Another well-known sugar-cane borer is a weevil (*Sphenophorus sacchari*), specimens of which now in the Kew Museum No. II., were received from British Guiana through Miss Ormerod in 1880. This has been recognised as injuring sugar-canes in Barbados last year, but the exact extent of its recent depredations in the West Indies has not been clearly worked out. A third borer which has made its appearance is a minute beetle, scarcely two lines long. This has been identified as *Xyleborus perforans*, and following Miss Ormerod it has been given the name of "shot-borer." The popular name is hardly distinctive enough, as it has been "indiscriminately used to denote many beetles belonging to distinct families and of dissimilar habits." As the "shot-borer" of the sugar-cane the name may, however, have currency for the present, and no confusion need arise. This small beetle has come into prominence as a destructive pest of sugar-cane with great suddenness. Within the last two years it is credited with injuring canes in Barbados, Trinidad, and St. Vincent to a serious extent. On some estates in Trinidad it is said to have caused a loss of 30 per cent. of the sugar-cane crop, whilst in some distinct fields as much as 50 per cent. loss has been incurred. These

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injuries to a large and important industry have naturally excited considerable inquiry on the part of sugar planters, and the aid of Kew has been sought in their behalf by the local governments as well as by the Secretary of State for the Colonies, with the view of affording all possible information on the subject.

The study of Economic Entomology has not received so much attention as it deserved in this country, but Kew has been fortunate in receiving valuable aid in regard to the elucidation of problems connected with the attack of insects on cultivated plants in the Colonies from Mr. Robert McLachlan, F.R.S., Mr. Arthur E. Shipley, F.L.S., and in the present instance from Mr. Walter F. H. Blandford, F.E.S., F.Z.S., Lecturer on Entomology at the Indian Civil Engineering College, Cooper's Hill. Mr. Blandford has devoted special attention to wood-boring beetles, and a valuable paper by him on "Insect injury to barrel staves" was published in the *Kew Bulletin*, 1890, p. 181. The numerous letters and specimens received at Kew in connexion with the sugar-cane borers in the West Indies have been submitted to Mr. Blandford, and he has now prepared an exhaustive report on the subject.

This report, together with the illustrations which accompany it, will prove not only of great value in guiding any further investigations that may be carried on during the next planting season, but they will enable those practically interested to recognise the several borers and especially the "shot-borer" which is the chief subject of Mr. Blandford's present investigations and lead to a conclusion, not yet clearly made out, whether these borers attack perfectly healthy canes or are merely the followers of previous disease or injury.

Report on Sugar-Cane Borers.

The ravages upon Sugar-cane of a small boring beetle, known as the "shot-borer," have recently attracted much attention, and aroused no little alarm among planters in the West Indian Islands. The matter is one of very great importance involving no little difficulty in ascertaining all the particulars of the insect's economy, and in basing methods of treatment on the results obtained.

The chief subject for investigation is the relation of the insect's attacks to the health and condition of the canes, whether it is a true destroyer, or merely a follower and manifestation of antecedent and more serious injury. This question I do not attempt to solve; it can only be studied in all its bearings by observers on the spot. I propose, instead, to summarise the chief facts known about the shot-borer identified as *Xyleborus perforans*, to indicate certain gaps in our knowledge of it which remain to be filled up, and to present the various opinions held on its attacks, and the evidence for and against them. The insect will be referred to in the following sections under either of the above names; it is, however, better to employ the scientific name, as the term "shot-borer" has been indiscriminately used to denote many beetles belonging to distinct families and of dissimilar habits, which agree in making shot-holes in wood.

The present account is based on the examination of all specimens and information received at the Royal Gardens, Kew, since January 1890, and on information collected by myself from other sources. I have also had access to all the documents in the India Office bearing on another phase of this insect's career.

So large an amount of literature is growing up round this insect, and so much of it is inaccessible, that it is hardly possible as yet to give an exhaustive account which shall include all recorded information.

Among the investigators who have examined these attacks and reported on them in the West Indies are Mr. Herbert H. Smith, St. Vincent (12, 13) : Mr. J. H. Hart, F.L.S., Superintendent, Botanical Gardens, Trinidad (15, 16, 17) ; Mr. J. P. d'Albuquerque, Professor of Chemistry and Agriculture, Barbados (18, 19) ; Mr. G. W. Smith, Curator of the Botanic Garden, Grenada, (20, 21), and other gentlemen.

Excellent specimens of various insects and specimens of canes have been received from Mr. J. R. Bovell, F.C.S., Superintendent of the Botanical Station at Barbados; from Mr. J. H. Hart, F.L.S., and from Mr. G. W. Smith of Grenada.

An important report (26) has just been issued by a committee of the Trinidad Field Naturalists' Club, which has made it necessary to revise and re-write much of the present account. I have found it most valuable, though I cannot agree with all the views expressed in it. This body has been referred to in my report as the Trinidad Committee, but it must not be confused with the committee appointed by the Central Board of Agriculture of that Island, which has also deliberated on this question.

In another category are the writings of Miss Ormerod (23, 24) and Mr. T. D. A. Cockerell (25), which are based, like the present paper, on reports and exported specimens, and not on personal observation of the injured fields.

Miss Ormerod has very kindly informed me that she has in preparation a pamphlet for the use of planters, &c. I have not yet had the opportunity of examining the information and advice contained in it, which would have been of great service to me in writing this account, as I know she has devoted much time and attention to the subject.

2. Historical.

This shot-borer has probably been known from early times to residents in the tropics, but, excluding a doubtful reference of Fabricius, it was first described in 1857 by Wollaston (2), under the name of *Tomicus perforans*. He recorded it from the wine stores of Funchal, Madeira, as feeding on the bungs of the casks, and was told that it was at times exceedingly troublesome.

He found it subsequently in the Canary Islands, burrowing in the wood of *Jatropha* (3).

About this time it attracted serious attention in British India and Burma, as a destroyer of beer-casks, and since then numerous official reports have been written on it, and much advice given, but its depredations have never been efficiently checked. The very important question, as to whether it was imported in the casks from Europe, has remained in continual dispute, owing, I believe, to the disastrous mistake of an eminent entomologist, who, in 1867, identified it wrongly with a North European species, *Xyleborus monographus*, Fabr., on the evidence of a drawing.

This mistake has had the effect of throwing the responsibility on the wrong persons, who have naturally declined to accept it, and the result has been to completely delay any settlement of the practical issues involved. The necessity of accurate study of species cannot be better exemplified than by this incident.

In 1857 Walker described it from Ceylon under the name *Bostrychus testaceus*.

In 1867 Eichhoff described *Xyleborus affinis* from Cuba, South America, &c., without identifying it with Wollaston's *Tomicus perforans;* but his very full account of both sexes enables the identification to be made with certainty when Wollaston's types are examined. This is an important fact, because a careful study of Eichhoff's exhaustive descriptions is absolutely necessary, when one undertakes systematic work on the genus (5).

Since 1867 further reports and observations have been made on the species as a cask-destroyer at the Entomological Society of London and elsewhere (4, 9), and the species attacking barrels in India was rightly identified with Wollaston's *T. perforans* from Madeira, by Mr. C. O. Waterhouse (9).

3. Recent Attacks.

The shot-borer came under notice as a destroyer of sugar-cane in the West Indies early in 1890, when Mr. Herbert H. Smith (12) sent it from St. Vincent, in company with the well-known cane-borer moth, *Chilo saccharalis*, Fabr.; I then identified it with Eichhoff's *Xyleborus affinis*, in which opinion Mr. Waterhouse concurred. This name, therefore, takes rank as a synonym of *X. perforans*.

Shortly afterwards Mr. Quelch, of the Museum, Georgetown, sent examples to the British Museum, as destructive to cacao trees. In answer to an inquiry, he informed me that the specimens came from Surinam, and that further information could not be obtained.

In the winter of 1891 and the spring of 1892 the attacks of the insect became so serious that numerous specimens of the beetles and of injured canes, with much information, were forwarded to the Royal Gardens, Kew, from Barbados, Trinidad, and Grenada.

I identified the specimens sent as *X. perforans*, Woll., and did the same for Canon Fowler, secretary of the Entomological Society of London from whom Miss Ormerod received the name. The responsibility for the identification is therefore mine.

Since that time there has been much attention paid to this beetle, as before mentioned, and in a year or so its economy will probably be thoroughly understood.

Specimens sent to Prof. Riley, of Washington, U.S.A., were named by him *Xyleborus pubescens*, Zimm. (26).

If this identification is correct, as is no doubt the case, this name also becomes merely a synonym of *X. perforans*. Mr. Schwarz records (10) *X. pubescens* as burrowing into a pine-tree, and though it is exceptional for a scolytid beetle to attack both conifers and deciduous trees, yet *X. Saxeseni* does so, and therefore so general a feeder as *X. perforans* may well do the same. Mr. Schwarz's description of the male of *X. pubescens* does not appear to me to tally very closely with that of *X. perforans*.

4. Zoological Characters.

Xyleborus perforans belongs to the family of *Scolytidæ*, or Bark-beetles. The *Scolytidæ* are small cylindrical weevils, distinguished from the majority of that group, the *Rhynchophora*, by possessing only a very short broad snout-like muzzle, or more commonly none at all, and with the shanks (*tibiæ*) of the legs flattened and toothed along their outer edge.

In the section *Tomicidæ* to which the *Xylebori* belong, the head is entirely covered by the hood-like prothorax, with a roughly asperate or grater-like surface sometimes confined to the front half, and the joints of the feet (*tarsi*) are linear and not flattened out into the broad fleshy pads generally possessed by weevils; the absence of these pads is, however, by no means universal among the *Scolytidæ*.

The antennæ are always geniculate, or elbowed, the first joint being elongate and set at an angle to the succeeding joints; this will serve to distinguish them from the very similar *Bostrychidæ* and *Anobiidæ*, which also bore into hard wood, and are known as "shot-borers."

The genus Xyleborus.

This genus was separated in 1864 by Eichhoff from the old genus *Tomicus*, and is distinguished by the following characters:—

Head globular, hidden under a rounded or cylindrical thorax, whose anterior half is densely asperate, or grater-like, the hinder half smooth and finely punctured.

Prothorax excised ventrally up to the anterior coxæ. Tibiæ flattened, dilated towards the apex with the outer edge rounded and serrate; the tarsi can be folded up against them.

Body cylindrical, elytra punctured in rows without a depressed line along side of suture.

Males much smaller than the females, of shorter and more convex shape; they are wingless, and fertilise the females in the plant where they are bred. They are by far the rarer of the sexes, the relative numbers varying from about one in four up to one in 30 or more, according to the species.

The genus contains about 90 described species, distributed over the world: about 25 have been described from Central America and Brazil.

XYLEBORUS PERFORANS.

Tomicus perforans, Woll. Cat. Col. Mad. 1857, p. 96.
. . . ., Col. Hesperid. 1867, p. 113.
Bostrychus testaceus, Walker, Ann. Nat. Hist. ser. 3, III. 1857, p. 260.
Xyleborus affinis, Eichh. Berl. Zeit. 1867, p. 401.
Rat. Tomicinorum, Liège, 1878, p. 372.
Xyleborus pubescens, Zimm. Syn. Scol. 1868, p. 145.
Schwarz, Ent. Am. II. p. 41.
? *Bostrichus ferrugineus*, Fabr. Syst. Eleuth., II. p. 388, 20.

Elongate, cylindrical, of a bright fulvous-brown, varying from pale testaceous yellow in immature specimens, sparsely covered with greyish-yellow hairs.

The *head*, invisible from above, bears two oblong black eyes, concave on their anterior edges, between which and the mouth are placed the *antennæ*, with an elongate basal joint, on which is set at an angle the five-jointed shaft, carrying an oval capitate club with a truncate hairy apex.

The *thorax* is cylindrical, half as long again as broad, slightly narrowed at base, with the anterior edge strongly rounded. In the middle of its upper surface is a rounded, somewhat transverse tubercle, in front of which the surface is rough and asperate, behind smooth, shining and finely punctured.

The *elytra* are nearly twice as long as the thorax, cylindrical with an obliquely flattened apex; shining with close rows of small punctures, the interstices between the rows having occasional scattered punctures. The first and third interstices bear at the apex of the elytra two or three small tubercles, each carrying a bristle. The second interstice is slightly depressed, and bears no tubercles.

The legs are yellow, and the *tibiæ* (shanks) have the outer edge rounded and set with saw-like teeth.

Length $1\frac{1}{3}$ lines (2·2–2·7 mm.).

Male smaller and shorter, thorax with a flattened triangular cavity in front, below which the anterior margin is prolonged into a small tubercle. Wings absent; elytra only half as long again as thorax, more convex and less cylindrical than in female.

A fuller description will be found under the name *X. affinis* in Eichhoff's *Ratio Tomicinorum* (l.c.).

Several species of *Xyleborus* are only doubtfully distinct from *X. perforans*, as *X. Kraatzii*, Eich., from Ceylon, and *X. interstitialis*, Eich., from Mexico.

5. Geographical Distribution.

Xyleborus perforans appears to be generally distributed in the tropical and sub-tropical regions. It has been found in British India, Ceylon, Burma, the Malay Archipelago (I possess specimens taken by Wallace in Batchian, Dorey, Celebes, &c.), Madeira, the Canary Isles, Mauritius, Rodriguez, the West Indian Isles, North America, Central America, Brazil, Guiana, Peru, &c., and probably Australia.

To some of these localities it has probably been imported through commerce, and it is not unlikely that its original habitat is in Tropical America.

It is not certain if it occurs commonly in India away from store-houses and go-downs. These borers are but little studied, and trust-worthy identifications of their species cannot well be made except by a specialist with the assistance of types.

It does not occur in Europe, but has been confounded with two European species, *X. monographus*, Fabr.; and *X. Saxeseni*, Ratz. (9).

Whether it occurs in all the West Indian islands, and how long it has been established in them, cannot be decided upon present evidence, but considering its wide distribution elsewhere, it has probably been in most of them for some considerable time.

Mr. H. H. Smith writes (12) "it is common in all parts of St. "Vincent, equally in districts where the cane disease has not "appeared."

Not having seen any record of it from Jamaica, I wrote there some time ago for any specimens of injured barrel staves, and duly found it in those sent. This fact is interesting in the face of the very ingenious *à priori* arguments advanced by the Trinidad Committee (26) to show the great improbability of the insect having been imported in barrel-staves, which they consider to be unsuited to its habits. I do not believe for one moment that it is a new-comer in the latter island, but if it is, there is evidence from all parts of the world that there is no more likely conveyance for it than a barrel-stave.

The insect's attacks have at present been recorded from St. Vincent, Barbados, Trinidad, and Tobago (meeting of the Central Agricultural Board of Trinidad, January 29th, 1892).

6. Food-Plants.

X. perforans has been found in mahogany and cacao-trees, in *Jatropha*, sugar-cane, the wood and corks of rum, beer, and wine casks, and is probably a general feeder in all dead but not dry woody matter.

Mr. J. H. Hart, of Trinidad, says (15) that it is found in quantity in old wood and furniture. This is a point of importance with regard to its attacks on casks, particularly empty ones, and these observations may be well confirmed by sending specimens taken from seasoned wood for comparison, to prevent any confusion between it and any of the very similar furniture-borers (*Anobiidæ* and *Bostrychidæ*).

The *Scolytidæ*, though attacking such hard substances as date stones and ivory-nuts, do not breed in dry seasoned wood, and if this species agrees in habit with other *Xylebori*, it can hardly do so even if it occasionally attacks dry wood as a perfect insect.

The wood of boxes sent to England containing canes full of live beetles in all stages was quite untouched, and I have not succeeded in getting them to bore into dry wood.

No remedy based on the supposition that it only feeds on sugar-cane is likely to be successful.

7. Life History and Habits of Scolytidæ.

The *Scolytidæ* in general differ from other beetles in the fact that the female burrows into the tree to lay her eggs (5, 7), usually turning parallel to the outside when the cambium layer is reached, and making a tunnel along the inner side of the bark at a greater or less depth. She lays her eggs in small cavities scooped out alternately on either side of this tunnel, which takes some weeks to excavate, and is sometimes forked or two-armed. The larvæ hatch and bore on their own account at first at right angles to the mother gallery. As the inmates grow their burrows widen, and generally take on an irregular course. The patterns so formed are fairly constant for the same species, and are often known as *typographs*.

The changes up to the perfect state are undergone in the bark, or sap-wood, and the imagos burrow out to the surface by separate holes.

A few genera bore deeply into solid wood; some like *Trypodendron* still lay the eggs in lateral cavities and the larvæ make separate galleries, in this case short blind tunnels deep in the wood. The newly disclosed insects pass along the mother-gallery to reach the outside of the tree.

The Xylebori.

The *Xylebori* do not feed under bark but in solid wood (by exception in softer tissues like the stems of Orchids, from which I have a species), and have therefore diverged farther from the ordinary type. The females construct a system of branching galleries, in which they lay the eggs, often in a clump. The grubs do no boring on their own account, but feed in the mother-galleries on fungoid growths and sap exuding from the walls. Here they undergo their transformations, emerging by the mother-hole, so that a single hole may give exit to a whole generation of beetles, and the external appearance of the wood gives no clue to the amount of boring within. Exceptionally, as in *X. perforans*, the immature imagos bore separate holes to the surface.

Some kinds hollow out an irregular chamber without any ramifying galleries in which larvæ, pupæ, and immature insects lie in confusion. This is the case with *X. Saxeseni*, for which *X. perforans* has been mistaken (9), but which differs completely in habits.

8. Life History of Xyleborus Perforans.

The females are fertilised by the wingless males in the burrows where they are born, and never in the air. They fly readily, chiefly by night (26), and are among the insects most frequently attracted to lights at night (12). "The females standing on the ridge formed by the knot of the "cane enters it by a hole, at the entrance to which is usually to be found "a small heap of filings of cane fibre; this hole she makes through one "of the rootlet eyes and deposits her eggs in it from 60 to 80 in "number" (26).

According to Mr. H. H. Smith (13) the beetles enter through the holes made by the larvæ of other insects (*Chilo saccharalis*, &c.). This is a point resisted by the Trinidad Committee. Though it is not the commonest mode of entrance, I believe, from examination of canes, that it sometimes does occur, and that burrows of entrance made in this way are distinguishable from exit-holes which strike the moth burrows in their course. Burrows can be found running from the moth-holes and then forking repeatedly, which would not be the case if they had been excavated in the other direction, when they would represent the terminal branches of a forking system. There is no reason why the beetles should not avail themselves of any means of entering the cane, whose hard smooth cortex protects the greater part of the surface from attack. In casks the beetle generally takes advantage of any irregularity or grooving on the surface of the wood when beginning its burrow.

The cane is usually attacked at a node about the middle of the stem, then the joints above and below suffer, and in some cases all the joints are full of beetles.

When it has entered the female bores out a series of galleries in the neighbourhood of the node, in which the eggs are laid. I have not seen specimens which were so recently attacked as to allow of the plan of these galleries being made out.

The larvæ, as with other *Xylebori*, remain in the mother galleries, and perhaps do not bore into the cane but feed on the juices. Prof. d'Albuquerque (18) does indeed refer to their boring, and the Trinidad Committee speaks (26) of the larvæ feeding on the juice in the passages *made by themselves*, but if attention has not been called to this peculiarity in the life history of the *Xylebori*, a mistake might easily arise.

I have not found separate galleries terminated by feeding larvæ, but have seen a row of living and mature larvæ lying in a burrow with their heads towards its exit, in a position where they could not have fed on the solid tissues. The grubs are active, and may be able to turn round in the width of the burrow, for I have seen one do so in a gallery which had been laid open longitudinally.

The Larva.

The larva is a white footless maggot, about two lines long, elongate and wrinkled. The head is horny and white, the jaws being tinged with brown, the whole weakly constructed. I have not seen them feed, but have observed one open and shut the jaws rapidly. When alive it is nearly straight, the usual downward curvature of weevil grubs being little noticeable.

The Pupæ.

The pupæ into which the grubs turn are also found in the galleries; they are white, about the length of the perfect insect, and of the ordinary beetle type.

"The larvæ are soon hatched, and feed for a month and a half. The perfect beetle appears after a fortnight or three weeks. The period of development from the egg to the perfect insect is about six weeks" (26)

These statements are obviously irreconcileable; allowing one week for the hatching of the egg, the period of development would seem to be about ten weeks.

When the perfect beetles emerge from the pupal skin they are almost white in colour and slowly become brown; they pass some considerable time burrowing up and down from the confused mass of galleries in the neighbourhood of the nodes, which in canes sent to England are full of rotting fungoid growth. These burrows run along the long axis of the cane between the vascular bundles, and fork at intervals, showing that more than one beetle has passed along them; the branches given off are sometimes oblique, but more often return almost immediately to the direction of the axis. Occasionally a transverse gallery runs almost round the cane just under the cortex without penetrating it; the same thing is seen in cask-staves, where burrows can be traced running in a straight line for two or three inches within a millimetre of the inner surface of the wood.

When the imagos wish to leave the cane they bore holes through the cortex, which are far more conspicuous than the entrance holes, then choked with dirt and fungus. All holes made in the internodes, except perhaps some leading from burrows of *C. saccharalis* (*v. supra*) are exit and not entrance holes. The holes made in the cane are circular, and correspond in size to the transverse section of the beetle. They are about $\frac{1}{40}$ of an inch (·6 mm.) in diameter. The internal burrows have the same width, but in cane which is not quite fresh, they will appear rather larger from the shrinking of the tissues.

Possibly the beetles sometimes lay eggs in the cane before their emergence, and thus more than one generation will be born there; and many beetles leave by the entrance-holes or the exit-holes of others, so that a piece of cane with but few exit-holes is often found riddled by burrows when cut open.

The number of broods in a year has not yet been ascertained. Those hatched when the canes are unripe are no doubt developed in cane or tree stumps, rotting canes, and moist megass; they do not breed in dried canes or megass (26).

There is not much information to hand on the time of year when the canes are attacked. They appear not to be touched till they ripen, and the worst attack is recorded to have spread most rapidly from the middle of November to the middle of December (16); when begun it goes on till the canes are cut.

The following points require further investigation :—

1. The time of year when the cane is usually attacked.
2. The connexion, if any, between the attack and the operation of trashing.
3. The character of the larval food. The capability of the larva to bore.
4. The time of development of the individual, and its duration of life.
5. The number of generations in the year, and of those passed in individual canes (if more than one).

6. Their ability to lay eggs in the cane without leaving it.
7. The ability of the beetles to attack or to breed in dry wood.
8. The per-centage of males to females.

I do not think I have seen more than eight males in the hundreds of specimens which have reached me. Their smaller size and different shape will distinguish them almost at a glance.

9. Natural Enemies.

These, if any, remain to be discovered. I have, however, found among specimens from St. Vincent a small beetle, *Læmophlœus*, sp., which was probably parasitic on the shot-borer. The habits of the *Xyleborus* give it great immunity from the attacks of insectivorous birds and ants, both of which have been mentioned in connexion with it (19), but a little observation should show if these are of any assistance. The *Scolytidæ* are not exempt from insect parasites (other *Coleoptera*, *Ichneumonidae*, and allied kinds).

10. Destruction caused by the Shot-Borer.

Putting aside the question as to whether this beetle is responsible for all the damage attributed to it, the serious nature of the outbreak will be seen by the following extracts.

St. Vincent.

Mr. Herbert H. Smith says (12), "My attention has been called to a "disease of the sugar-cane, which has lately appeared or increased on "this island . . . As yet it seems nearly confined to a few localities, "but there are indications that it is spreading. In some instances, "the managers of estates report that, at least, twenty-five per cent. of the "products will be lost.

"The canes attacked are, so far as I have noticed in one field, scattered among the sound ones, often on the same hill. They are easily recognised by their dwindling rapidly at top, and by their withered leaves; the colour is often paler than usual . . . . The cane in the worst cases is quite rotten or dried up and almost devoid of saccharine matter—in other cases it has the characteristic sour odour of acidulated cane-juice."

Barbados.

"Cane-fields which have been attacked present a dried and withered appearance and the canes seem quite rotten. In St. Vincent and Trinidad it is doing terrible damage, and in some cases as much as one third of the crop is spoilt and no one knows how it will end" (18).

Trinidad.

"The cane-fields are first affected on the outside, and the scourge rapidly extends to the whole field, affecting at least 20 per cent. of the canes" (16).

"With regard to the damage done in Trinidad we understood that one planter has sustained a loss of 30 per cent., of his crop, whilst in some distinct fields as much as 50 per cent. loss has occurred" (26).

"The canes show little or no sign on the outside until the mischief is well advanced. It shows itself in small spots like a bruise, which, when examined, reveals the fact that the cane is of a red colour right through the centre and quite sour. We have had to condemn heaps of canes for this reason. The attacks make the juice poor, and the acidity is difficult to manage.

"The disease appears seriously to affect the quality of the Muscovado sugar. Our first cargo of this season, which is just landed in Philadelphia, U.S., shows an average polarization of 85·36 against 89·4, that of our first cargo last year" (22.)

11. Causes which predispose the Canes to Attack.

Before considering this, by far the most important question for investigation, it will be profitable to refer to a very old controversy as to whether the *Scolytidæ* ever attack healthy plants or not.

The strongest opinions have been held about either side of this question, and much has been written upon it (7, 11).

The truth probably is that they avoid sound trees when sickly or dying ones are to be had, but do not hesitate to attack them when the supply of suitable brood-material is insufficient, and any cause has brought about an exceptional increase in their numbers. In temperate counties such an increase may be caused by an unusually hot season, which by multiplying the annual number of broods, enables them to outstrip their natural checks, or by a plentiful supply of food material in any one year arising from forest fires, damage by storms or snow, defoliation by caterpillars, drought, &c. An attack on healthy trees is usually unsuccessful at first, and the tree repels the invaders by pouring out sap into the newly made burrows, but if continued year after year the tree becomes gradually weakened and at last succumbs. In other words, they live only in unhealthy trees, and it is when they have at last succeeded in diminishing the vitality of a tree that they are able to breed in it.

Another cause that has been advanced as a possible forerunner of their attacks is the presence of a parasitic fungus, as *Agaricus melleus* (11).

As any temporary check to the health of a tree, *e.g.*, transplantation or partial loss of foliage, from which it would have recovered, may allow the beetles to establish themselves, the fact that they do not habitually attack trees in sound health does not deprive them at all of economical importance.

The Plum Tree Shot-Borer.

The *Xylebori* differing from most of the family in boring deeply into the wood, instead of attacking the inner bark, are as a rule less injurious, and no European species is conspicuous as a destroyer of standing trees, except *X. dispar*, Fabr., the Plum-tree Shot-borer, which sometimes attacks young deciduous trees or branches of ½ to 2 inches in diameter. A case of this kind, where the trees were apparently healthy, has been recently recorded from Gloucestershire by Miss Ormerod (Report on Injurious Insects for 1890). Yet, in spite of these attacks on apple, pulm, and oak trees, &c., it cannot be doubted that the natural breeding place of *X. dispar* is in newly fallen trees of larger diameter, chiefly oaks and beeches.

In such the system of branching galleries reaches its normal development, whereas in young saplings it is distorted and altered, showing that these do not represent the original breeding place of the beetle.

Eichhoff, the authority on these insects, says distinctly (7) that *X. dispar* avoids sound wood for breeding purposes, if dying or newly felled timber is to be had.

There are no sufficient facts to contradict this.

Schmidberger, who first accurately recorded its habits (1), did not observe its attacking felled timber, and though Altum is quoted by Eichhoff (7) as denying the fact in his "Forstzoologie," the denial does not appear in the second edition of that work (8).

I have myself found it abundant in felled trunks in Belgium, and never in living trees.

The bad attacks on saplings, which have been observed from time to time, have begun and ended suddenly, without leaving observers in a position to point to any definite disease or peculiarity in the trees which should make them specially attractive. As the species is one of our rarest English beetles, the Gloucestershire attacks cannot be ascribed to "excessive multiplication;" possibly no proper brood material was present.

The difficulty in clearing up the economy of a well-known European and American insect like *X. dispar*, and the fact that it deserts its usual habits to become destructive, are of great assistance in considering why *X. perforans*, which has perhaps been abundant for many years throughout the West Indies, has seriously attacked the sugar-canes in a small number of adjacent islands. At the same time the analogy between *X. dispar* and *X. perforans* need not be pressed too far. The habits of these borers differ very much, and must be considered separately; those of one species form a useful guide to those of another, but it does not follow that the latter are in all respects the same.

I. *Is the attack entirely independent of the health and condition of the canes?*

II. *Does it depend upon a deterioration of their health which renders them attractive to the beetles?*

In the latter case is the deterioration due to—

1. *A weakly state caused by continual propagation of the same variety on the same soil, &c.:*
2. *To drought:*
3. *To fungoid disease present in the cane:*
4. *To previous attacks of other insects?*

III. *If there is a definite cause which favours the attack, is it the same in all islands where the beetle has been injurious?*

These are the questions which remain to be answered, and to be answered by investigators on the spot, for I do not believe that the examination of exported specimens will give the solution to them.

Many short pieces of cane have been sent over in alcohol, which show admirably the burrows of the *Xyleborus*, which will wrongly pass as the sole destroyer, if other insects have attacked that part of the cane which has not been presented for examination.

Canes cut in 3–4 feet lengths do indeed show other insect attacks if present, but are useless as indicating the general health of the plant, for they arrive rotten and sour, and it is impossible to determine whether that state has been set up before or after cutting.

The burrows of these shot-borers always contain more or less fungus, and when old are often black inside as if charred; therefore a plant attacked by them is certain to show evidence of fungus.

I have examined a consignment of eight or nine long canes sent from Trinidad to Kew by Messrs. C. Tennant, Sons, & Co. (22). They were full of burrows of *X. perforans*, many being fresh and containing living larvæ, pupæ, and perfect insects. The galleries occurred in all or nearly all the joints, especially at the lower part of the cane. *Every cane showed as well in one or more joints the burrows of a larger insect, of which six or seven occurred in some canes.* These were of older standing, and full of fungous growth, and as the insects which had caused them were not present, it is impossible to state positively the species.

In one or more instances the remains of a cocoon show with practical certainty that the insect was a weevil, probably *Sphenophorus sacchari* (25); from the evidence of another cocoon, *Chilo saccharalis*, the "borer-moth," was also present, and this species probably caused most of the damage. In one cane the three lower, and in another the two lower joints were hollow and rotten. This looked like the work of a large *Lamellicorn* beetle-larva, or a *Rhynchophorus* weevil. We may fairly conclude that in these particular canes the attack of *X. perforans* has followed that of other insects more especially, because one cane at least was free from the *Xylebori* altogether.

It would be possible to cut from some of these canes 1–2 foot lengths which should show no injury but the burrows of *X. perforans*.

Nevertheless, the fact that half a dozen canes have been previously attacked by other pests before *X. perforans* has touched them, though affording a strong presumption that the injury made those canes specially attractive, is no proof that the shot-borer cannot begin an attack on its own account. This can only be determined by examining a large number of canes, and counting the proportion of those attacked by *X. perforans* alone, in conjunction with other insects, and by the latter when it is not present.

Those who have studied the attacks in Trinidad, namely, Mr. J. H. Hart and the members of the Trinidad Committee, are disinclined to attribute the mischief to previous insect attacks, as is done by Mr. H. H. Smith, Mr. G. W. Smith, and others. Professor d'Albuquerque accepts *X. perforans* as the true destroyer, but as he does not discuss the question of its being a successor of other enemies, it is impossible to say from his report (18) if he has considered it.

The Trinidad Committee (26) does indeed go so far as to "believe "that the beetle is the primary cause of the disease, and that it is "immaterial to the beetle whether the cane is healthy or not," but they do not refer to the very important remarks contained in the next section. In this and in subsequent sections the opinions of various observers are given in inverted commas; the italics are mine.

12. Is the Attack favoured by want of Vigour in the Canes?

Mr. Hart in his report (15) says:—"Mr. Bovell and Mr. Coull also "agreed with my suggestion that the *method of propagating canes* "*year after year from the same stock*, the same fields, and often from "abandoned lands was liable to induce constitutional weakness."

"Canes, though possessing vegetative vigour and apparently robust health, may at the same time be what I would term constitutionally weak, and liable to attacks of blight occasioned either by the attacks of insects or fungi.

"With this view a most minute examination was made into the results of the Dodds' experiments with seedling canes, as it was expected that increased vigour would be found among the seedling varieties; my

views were fully confirmed, and there were found at Dodd's magnificent varieties of canes raised from seed, which have no sign of being attacked by the beetle-borer so destructive on St. Augustin, although in a neighbouring estate this same insect was prevalent and producing similar results as in Trinidad."

"I have noticed that the Transparent Cane and the Caledonia Queen *enjoy an entire immunity from the attack*, even when growing side by side with the badly infested Bourbon canes, and it has occurred to me that perhaps the Bourbon cane, enfeebled by long cultivation in the same land, and degenerate *from the careless way in which the propagation* (particularly in these islands) has been conducted, has now become powerless to resist the attacks of the moth [*Chilo saccharalis*], and that it would be as well to select and introduce a new variety" (20).

This last report was written by Mr. G. W. Smith, of Grenada, who believes that there the beetle follows the attacks of other insects, but it shows that there is a probability that those also depend on the canes being constitutionally weak.

Too much importance cannot be attached to these remarks, which may go to the root of the whole question, and it is greatly to be regretted that the Trinidad Committee has not dealt with it in their report.

The matter has, however, received attention at a meeting of the committee of the Central Agricultural Board in Trinidad, where in the discussion of Mr. Hart's views the objection was raised that the canes he had referred to as constitutionally weak had been most carefully raised.

Mr. Hart quite rightly pointed out that the two things were distinct. It is perfectly well known that many of the finest cultivated varieties, say, of apples or potatoes, are very liable to diseases or insect attacks, apple-canker and the like, and that this liability is not to be explained by defective cultivation.

It will assist investigations very much if planters can be induced to consider the possibility of the attack being favoured by constitutional weakness, or "receptivity" of the canes, and at the same time to recognise that an admission of the fact in no way implies want of care in cultivation, but, perhaps, if anything, the reverse.

13. Is the Attack due to Drought?

One member of the Trinidad Committee (26) "desires it to be placed "on record that he believes the canes, owing to abnormal conditions of "weather, are not what may be termed perfectly healthy, which fact is "borne out that the juice has this season been rather poor. The general "appearance of growth does not show this in any marked way, but "manufacture does."

"The blight being right through the West Indies points more to the canes having been affected by the unusually hot dry season last year, than to its being caused by any local surroundings" (22, extract).

This would unquestionably favour the attack, but the beetle has not begun its depredations this year for the first time, and it can hardly be the chief cause. It is noticeable that the members of the Committee are not unanimous about the sound general health of the canes.

14. Are the Canes suffering from Fungous disease?

This a point upon which evidence is much wanted.

Mr. J. H. Hart writes (17):—

"I find in all canes attacked by the beetle (*Xyleborus*) that the mycelium of a fungus is present (especially at the node), which per-

meated the cells of the cane in all directions, whether apparently healthy, or having unhealthy and sour contents.

"As this parasite develops, it tinges the cells of the cane with a faint red tinge, which gradually deepens in colour to a bright red as time goes on. This action has formerly been attributed to the action of the insects but the same colour and the same mycelium has been found by me in a cane untouched by either the 'Old cane borer' (*Diatræa saccharalis*), or by the new borer or beetle (*Xyleborus perforans*, Woll). I found the wood of mahogany and other woods attacked by the Xyleborus was also permeated by the mycelium of a fungus. This points to the conclusion that the destruction of the canes is first begun by the fungus, and when sourness [or an acid condition] arises is followed by the attacks of its insect enemies.

"Personally, I do not wish this view to be received as fact until it has been confirmed by others. . . .

"I learn from Prof. d'Albuquerque that he has also noted a fungus to be present, and that he was glad to have his attention directed to the subject of its investigation."

This is so important that it will be well to throw further light on the subject, by having canes examined by an expert in phyto-pathology, who will give instructions for the proper preservation of specimens, if it is necessary to send them out of the island.

As mentioned before, the burrows of *Xylebori* are habitually lined with a mycelium on which the larvæ partly feed; this is not necessarily a forerunner of the insect, and care must be taken to see that no confusion arises as to the sequence in time of the insect and fungus. *The possibility of fungous disease of the roots being present should also be considered.*

The following paragraph shows that the question of fungous disease is worthy of far more attention than it has received :—

"Dr. Benecke, the Director of the Experimental Station at Klaten, Java, has offered a prize of 1,000 marks for the best essay, founded on original observations and experiments in cultivation, on the causes of the red colour in the fibro-vascular bundles of *Sorghum*, which accompanies the disease known as 'Sereh.' A very similar disease has recently become very destructive to the sugar-cane crop in Java."—*Nature*, June 30, 1892.

The Trinidad Committee has not adopted Mr. Hart's view; the report says (26) :—

"Mr. Hart has propounded a theory that the cause of the *Xyleborus* attack is the attraction offered by a microscopic fungus beginning at the knot, which permeates the cells of the cane in all directions irrespective of whether it is healthy or unhealthy, or has sour contents. It is quite possible that such a fungus—the committee has not yet found it—would cause the cane to sour, when it would assume this red tinge, but the committee differs from Mr. Hart when he says that this tinge has formerly been attributed to the insect, but that it is not the case . . . The committee has seen hundreds of cane stools with the red tinge which had not been attacked by the borers who had attacked the stools in the immediate vicinity which had not got the red tinge. Mr. Liddelow, a well known planter, in answer to some questions put to him, assured the President of this club that he had many canes with a red tinge which in his opinion was owing to the sun."

This report speaks of Mr. Hart's theory as if it were a mere speculation on his part. At all events, he says definitely that he has found a fungus present.

The acidity of the canes, a marked feature in the attack, the committee believes to be "produced (1) by the borers' interference with "the circulation of the sap, and (2) by the fermentation of the excre- "mentitious and other deposits in the burrows." But why not the fermentation of the cane juice itself? This souring, which must be set up by vegetable organisms of some kind, as yeast or bacteria, is no doubt greatly increased by the presence of the beetles; but there is good ground for supposing that they are attracted by that sour smell of fermentation which is often very marked in the wood of beer casks, and in the bark of the dying trees which they frequent, or possibly by the smell which precedes the actual souring, accompanies the early stages of fermentation."

Mr. G. W. Smith writes (20), "I have also observed that if you are careful to select specimens of withered and shrunken canes, from which the moth has not over long emerged, you will sometimes, but very seldom, find a beetle in them, but if they remain some time after *and have acquired a sour smell* (which very often can even be perceived by human observers) *you will always find on cutting open such a cane that it is full of the beetles.*"

Also in a subsequent letter he says (21), "Mr. Bovell writes me that he has noticed *X. perforans* in sour cane which showed no traces of the moth borer, and also that he has observed *diseased canes without a trace of either moth or beetle*, and I have noticed the latter (but not the former) in a few instances, but they are not at all common."

15. Is the presence of the Shot-Borer dependent on previous Attacks of other Insects?

This view has been held by several observers, and is supported by important evidence, but is rejected by the Trinidad Committee (26), at least as far as that island is concerned.

St. Vincent (1890); Mr. H. H. Smith reports (12), "The specimens "examined by me have been attacked by two insects, one or both of "which are certainly the direct cause of the disease." [One proved to be *Chilo saccharalis*, the other *Xyleborus perforans*.]

In a second report (13), he says, after describing the attacks of *C. saccharalis*:—

"Finally, if the cane is pretty well grown, the action of the air that has entered sours it; it then becomes attractive to several kinds of small beetles, but especially to a little brown cylindrical species of the family *Scolytidæ*; they often burrow through the acidified cane in immense numbers, and are commonly supposed to be the cause of the disease. I myself thought so, when the first specimens of cane were sent to me for examination; these were very bad cases and full of the beetles, which I naturally supposed to be the prime cause of the trouble. I now know that they are simply a result of it; *they never get into the sound canes, and often are not found in the diseased ones*: only in very bad cases where the cane has become acidified the beetles enter through the holes made by the moth larvæ for their exit.

"As the cane is already spoiled, or essentially so, the work of the beetle counts for nothing in the final loss."

The statement that the beetles enter through the moth-holes, though true to some extent, does not describe the usual mode of entrance at the nodes.

Mr. Herbert H. Smith is an experienced naturalist who was in St. Vincent for purposes of entomological research, and great weight attaches to his opinion.

From Grenada Mr. G. W. Smith reports (20)—

"1st. There is an old and well-known pest (*Diatræa saccharalis*) found in the diseased fields along with the beetle.

"2nd. Out of over 100 examples I have taken from a diseased field I have never found the beetle in canes that had not been previously attacked by the larger 'borer,' . . . , but on the contrary, I found numberless instances of canes, where the devastation done by the 'borer' (larva of the moth) was present, in which canes there is not a trace of the beetle. These examples I am not satisfied with, and shall continue to collect until I have about 400 good canes, when I should say the evidence would be conclusive, viz., that the beetle is one of the 'sequelæ' to the ravages of the moth 'borer' and not the real destroyer of the cane.

* * * * *

"I have secured about 30 specimens [of canes containing moth larvæ]; it is remarkable that in all these 30 specimens where the larvæ of the moth is actually at work, there is no sign of the beetle (except in one specimen two small holes, and there the moth is in the pupa stage), and the cane is withered and presents the same appearance as it does at Trinidad and elsewhere. I may be wrong, but I think this is how it occurs:—When the cane is younger, the larva of the moth commences its work. At first the cane shows no sign of attack, and planters who are not very close observers of such matters notice nothing; but as soon as the cane shows signs of withering and shrinking they first notice it, that is, when the moth has either already emerged or is just about to do so. Canes of the former type are then taken, cut open, and in very many cases found to contain the beetle, which is set down as the cause of the canes' decay.

* * * * *

"Owing to the ravages of the moth-borer, the *juice of the cane has become sour, and acquires a distinct smell.* The beetles are then drawn to it (to feed on their natural food), and hence their presence in such numbers in diseased canes. I have also taken a specimen of sound cane in which there was no trace of either moth or beetle, pounded it so as to rupture all the tissues, and flung it aside, *away from any cane-field;* after some time these same beetles are found in it, hence I conclude, it is, in a sour state, their natural food."

The latter remarks point to megass being very attractive while it is fresh; this has been observed by the Trinidad Committee (26).

Mr. G. W. Smith writes later (21):—

"I have further to report that a few days ago I received eight sugar-canes from Barbados. On examining them I found the small beetle, *X. perforans*, to be the same as that attacking canes in this island, but in addition I found in three of them the tracks of a much larger beetle that makes for itself a kind of nest or cocoon from the cane refuse as it eats its way through.

"I was able to secure three nests, and in two of them I found the perfect insect, which I send in a bottle of alcohol, together with the nest in which it was found; also a piece of sugar-cane showing the track made by it; this closely resembles that of the moth-borer, but I have not yet found this beetle in Grenada."

This insect sent was the weevil *Sphenophorus sacchari*, Guild., which was partly responsible for the larger burrows in the canes I have

examined from Trinidad. Mr. T. D. A. Cockerell has also found a specimen of it in Barbados cane; and writes (25) :—

"Thus it appears that the sugar-cane pest now causing injury in Barbados is not the *Xyleborus*, and not even the *Diatræa*, but the *Sphenophorus*, or weevil. This is, of course, so far as one can tell from the specimens received; but it is likely enough that the borer-moth also occurs in Barbados, and is reponsible for a part of the damage. It is clear, however, that the *Xyleborus* follows the depredations of the weevil as well as those of the moth."

This statement, though very likely true, is perhaps rather positive, considering the small amount of material he appears to have examined. My specimens from Trinidad showed previous signs of the *Sphenophorus*, but in the face of other evidence from the island I cannot possibly say on the testimony of eight canes, that that insect is the necessary forerunner of the shot-borer.

The evidence in favour of the *Xyleborus* following other insects is thus very strong, but the Trinidad Committee says (26) "Mr. Smith of Grenada has advanced the theory that the *Xyleborus pubescens* [=*perforans*] attacks the canes already subjected to the ravages of the large borer *Diatræa saccharalis*, and Mr. Cockerell of Jamaica is of opinion that it invades canes infested by the species of *Curculionidæ* (meaning it is supposed the *Sphenophorus*)."

"From these opinions, however, the Committee are compelled, by the results of their observations, to differ, at any rate so far as Trinidad is concerned. In the course of their researches the committee have found canes *which had been attacked by the large and small borers simultaneously*. In some cases the attack was made exclusively by the large borer, in others, and far more frequently, the small borer was the offender and the large borer was not present in any form. The committee is of opinion that the borers act independently of each other and that one does not follow the other. The burrows of the large borer are much too large for the purposes of the small one. In certain cases the burrows of the small borer may seem to branch from those of the larger one, but the small borer did not enter the cane by the large borer's hole, and the reason is that the small borer in the course of his travelling operations broke into the excavations of the larger insect. The committee is glad in this particular theory to have the support of Mr. J. H. Hart of the Botanic Gardens, who also condemns the idea of the small borer attacking the canes which have been entered by the large borer. Messrs. Cockerell's and Smith's theory, however, would be quite consistent with the habits of the *Xyleborus*, as they are usually understood, but then in Trinidad we have to reckon with the complete change of habits of these insects. Even supposing that the *Xyleborus* retains some of its former instincts it would not even in that case make use of the large borer's hole to effect an entrance into the cane."

These remarks call for comment. Firstly, the Committee speaks of canes "which had been attacked by the large and small borers simultaneously." This may, of course, be merely a piece of loose writing, but if the word "simultaneously" is to be taken literally as meaning "at the same period of time," it is opposed to the evidence of other observers and of the canes from Trinidad I have myself examined, in which the attack of the *Xyleborus* was begun decidedly later than that of the moth-borer or *Sphenophorus*.

Again, the theory that the shot-borer is attracted to canes damaged by other borers is not in the least dependent on the fact of its entering their old holes, which fact was never stated by Messrs. G. W. Smith

and Cockerell, to the best of my belief, but by Mr. H. H. Smith (13), and to which I have previously referred. The theory is that it is attracted by the sour smell caused by fermentation resulting on the injuries of other borers, and the Committee themselves say (26) about the *Sphenophorus* "it exhausts the saccharine fluid in the joints in " which it has lodged, filling the excavation it has made with an " excrementitious deposit injurious to the juice, *causing acidity, and* " *deteriorating it rapidly.*"

They refer to a complete change of habit, and imply that it has in Trinidad alone given up customs usual elsewhere. For what reason?

It is very greatly to be regretted that almost all who have studied this question have not taken a sufficiently broad view, but have imagined that the cause of the insect's increase must be nailed down to some one particular circumstance to the exclusion of everything else. The reasons for the multiplication of destructive insects are generally complex. Every species finds itself surrounded by a multitude of circumstances which tend to diminish its increase (*natural checks*), and others which tend to favour it. A failure of these checks alone will cause excessive multiplication, as is sometimes seen in the case of an imported species. Its enemies are not imported with it, and the insect flourishes in a strange land where it is secure from the attacks of parasites, &c. which formerly preyed on it. So, too, an abundance of suitable food, an unusually hot season, &c., may cause undue increase, and all favourable causes may operate together, when the result will be far more serious. Of course in one locality its multiplication may depend on a circumstance which is of little weight elsewhere, but it is safe to assume that whatever cause favours an insect's increase in one place will favour it in another, if it be in operation. Change of habit very rarely means change of the natural instincts of an insect, simply that its environment has been modified and that those instincts have caused it to strike out along the new line open to it. And I cannot agree with the theory of the Trinidad Committee that the insect has developed a taste for sweets in that island, which it does not possess elsewhere.

It is quite permissible to suppose that in Trinidad the insect has extended its attacks to canes which it usually leaves untouched, owing to their possessing a great variety of attractions, or to its excessive multiplication, without disregarding what has elsewhere proved attractive. It is not found that when a species like *Xyleborus dispar* turns to unrighteous courses, and injures growing trees, that it gives up its old habits; on the contrary, the system of establishing "tree-traps" to catch it depends on the fact of its being ready to resume them under favourable circumstances. These "tree-traps" consist of freshly felled trees, or cut logs which the beetles enter by preference for the purpose of egg laying, and which are removed and destroyed with their inmates.

The predisposing causes to which I have referred are in no way mutually exclusive, and the most that can be said is that in Trinidad the exceeding numbers of the insect, or the exceeding weakness of constitution, &c. of the sugar-cane, have reduced what is an important attraction elsewhere to a secondary and unimportant position.

I do not doubt that the observations of the committee are accurate, but the question as to the influence of previous borers can be easily tested, as follows.

Choose a field which is attacked both by the larger borers and the *Xyleborus*, and reckon the canes without selection till a large number, several hundred, have been examined; the more the better.

Divide them into those attacked by the larger borers (A) and those free from them (B). Count the number in each lot attacked by the *Xyleborus*, and estimate the per-centage.

If the *Xyleborus* attacks are in no way dependent on the presence of the large borers, the per-centage of canes infected by it in A will be the same as of those in B. If, on the other hand, there is a larger proportion of infested canes in A, it is manifest that either—

1. The *Xyleborus* follows the larger borers, because they have made the cane suitable for it.
2. The canes in A are suffering from some peculiarity which renders them specially attractive to *both* the large and the small borers.

So that in neither case if the per-centage is greater in A can it be said that the attack of the *Xyleborus* is independent of the health or condition of the canes.

The Committee, strengthened by the opinion of Prof. Riley (26), attribute the increase of the *Xyleborus* in Trinidad to the neglect to burn megass and refuse. This would, of course, favour the insects, but will not explain the outbreak completely, unless it can be shown that the increase has coincided with the period when the destruction of refuse was given up, and that in countries, as Guiana and Jamaica, where the insect occurs without attracting notice as a cane-pest, the megass is so treated that it cannot breed therein. Mere multiplication of the numbers of a Scolytid beetle need not involve injury to healthy plants if there are sickly ones to attack; but if due to increase in the amount of brood material caused by exceptional circumstances in any one period, it may bring about an attack, or an attempted attack, in following years, *when the supply of food has fallen to the normal amount*. In these islands there is plenty of suitable brood material, and it is remarkable that canes attacked by the larger borers should ever be free from the *Xyleborus* if its destructive habits are simply due to "overcrowding." If it has been a native of the islands for a considerable time, and has lived on a variety of other plants beside sugar-cane, clear evidence is required of very material alteration in the state of the cane-fields in the last few years before this can be accepted as the sole cause of its increase, and, therefore, of its destructiveness. For if its increase be due to this alone, it does not explain the point which the Trinidad Committee urges: that it has not merely extended its attacks to a certain proportion of sound canes, because all the unsound ones were used up, but has actually given up what is attractive elsewhere, namely, canes injured by other borers. Fortunately, it will not be difficult to check increase arising from such a cause as the neglect to burn megass.

Amongst the insect attacks on sugar-cane, there is one which is likely to be overlooked except by careful observers, that of a mite which has been found to attack the cane in Barbados and Queensland.

Mr. A. D. Michael has written an account of this animal, which is an Acarus and not a true insect (14).

16. Conclusions.

It will be seen that the exact character of the causes which favour the *Xyleborus* has not been fully determined, but requires further investigations, and it will be well if such are made, not with the idea that any one circumstance is solely responsible for its attacks, or to

support the observer's preconceived theories, but that all possible circumstances may be fully considered and examined in order to apportion to each its due value.

Granted that the canes must be under the normal standard of health to be attractive, it is probably a matter of indifference to the insect whether they have deteriorated through fungous diseases, the presence of an insect or another, &c. so long as they are in the desired state.

The importance of the insect is not lessened by the facts of its wide distribution and varied habits, which I have been able to record. Every entomologist knows that of two species of insect which are hardly distinguishable to the naked eye, one will be rare and barely able to maintain its succession from year to year, whereas the other will occur everywhere and flourish under the most diverse conditions. It is to the latter group that the really injurious insects belong, and among them is *Xyleborus perforans*, the destroyer of barrels in India, Jamaica, Madeira, and probably Australia, of trees in South America, and of sugar-cane in the West Indies. Its record of destruction makes it far more formidable than if it had never occurred away from the cane-fields, and it is earnestly to be hoped that no efforts will be spared to make that thorough inquiry into the causes of this outbreak in the West Indian Islands upon which alone measures of treatment can be properly based.

One other point must be touched upon. It has been often noticed that the attacks of an injurious species gradually increase to a maximum, and then cease for a considerable time. This is especially the case with defoliating caterpillars, through causes which need not be now discussed. It may be the case with this beetle; and if so, its decrease may be wrongly ascribed to remedies which have not really checked it. In view of the possibility of attacks at a later period this must be kept in mind should necessity arise.

It is usual to conclude a discussion of this kind with an expression of opinion. The impression left upon my mind by the whole of the evidence I have examined, to some of which I have not found it necessary to refer, is that:

1. *The attacks of Xyleborus perforans are not independent of the health or condition of the canes.*
2. *No one single cause will account for them in the different islands.*
3. *A constitutional weakness of the canes is a favouring circumstance.*
4. *Previous attacks of other borers are another, which may, however, depend on 3.*
5. *In Trinidad excessive multiplication may possibly have had something to do with it, but this multiplication must follow antecedent favourable circumstances.*
6. *The effects of fungoid disease and of drought upon the attacks require more consideration before they can be accepted as furthering them. There is, however, no reason why these causes, if present, should not operate.*
7. *There is reason to suppose that the beetles are attracted to any cane which has soured.*

I am prepared to change or modify any of these opinions upon further evidence, and I do not think that the time has come to assign to each possible circumstance its relative weight as a factor in producing the attack.

17. Economical Treatment.

If one cannot as yet dogmatise about the causes which have led to this outbreak, still less can one suggest measures which of necessity depend on a proper understanding of those causes, and, as a rule, on an intimate acquaintance with cane-growing.

When once its origin is thoroughly understood there are plenty of persons in the West Indies quite competent to apply remedies of their own devising without outside assistance; it will therefore be sufficient to suggest what class of remedies should and should not be looked to as being of service.

The economic treatment of an insect pest is of two kinds, *preventive* and *remedial*.

Preventive treatment is that designed to check the future spread of the insect to a wider area, or to stop attack on growing plants as yet untouched, even at the expense of those already infested, as for example, the cutting out and burning of attacked canes.

Remedial treatment aims at saving a plant by killing the insects on it, as when trees are sprayed to destroy blight or scale.

No *remedial measures* in this sense are possible for canes injured by the shot-borer; when attacked by it they are lost, and though they may be perhaps made useful if cut out and crushed at once, there is no way of saving them as growing canes.

The former is therefore the only treatment to be discussed.

18. Increase of the Constitutional Vigour of the Canes.

This may probably be the most important practical measure, if it be true that the Bourbon canes are constitutionally weak.

Mr. G. W. Smith has pointed out (20) the immunity of the Transparent, Ribbon, and Caledonia Queen canes, and Mr. Hart that of seedling canes (15).

The latter recommends securing constitutional strength by the selection of a suitable variety raised from seed [or otherwise]. The objections advanced to this, that seedling canes do not yield a sufficient per-centage of sugar, must be left to experts to compare with the loss occasioned by the borers.

19. Measures of Cultivation.

The unanimous opinion is that the cultivation of the attacked canes, at least on many estates, as the *St. Augustin* estate in Trinidad, is thoroughly good and cannot be improved.

Manure has been recommended by one cultivator against the attack (26), but is not likely to produce a good result. Chemical manure (kai nite or nitrate of potash) has been applied to canes in Queensland to kill underground grubs (25), on which it acts as a direct poison and not by its manurial value.

It would be no good against the borer, and the idea that manuring was useful might lead to excessive employment of it. It has been shown in the case of cereals that over-manuring with nitrogenous fertilisers results in rank growth, and a weak stalk which is readily beaten down by wind; now the Bourbon canes have a thinner rind than the

varieties not attacked, and anything which pushed them to excessive growth might make them more susceptible by increasing this peculiarity.

Perhaps this may explain why on some of the best managed estates the attack has been worst, because excessive vegetative vigour sometimes tends to "constitutional weakness."

20. The Destruction of other Cane Pests.

This is an obvious necessity if the attack of the shot-borer depends on their presence. The treatment of *Chilo saccharalis*, the sugar-cane moth, has been so often discussed that it is not necessary to go into it. The most recent account is that of Mr. T. D. A. Cockerell (25), published with a bibliography in the *Bulletin* of the Botanical Department of Jamaica.

The treatment of the weevil, *Sphenophorus sacchari* is less clearly known; a useful account of this and other cane pests was given by Miss Ormerod at the Entomological Society of London (6), and has been reprinted in the "Barbados Agricultural Gazette" for March 1892.

21. The Destruction of Brood Material.

Measures for this have been most generally recommended and adopted.

They consist in—

1. Burning trashings, megass, rotting and diseased canes and all other refuse.

With regard to the two former, I have no evidence yet that the beetle breeds in trashings, that is, in the cut-off leaves. It does occupy megass in abundance but only just when it is moist, that is, when it will not burn. Dry megass and canes which would be naturally burned it does not breed in; but they might be useful to make the others burn.

Whether trashings, megass, and any other refuse are gathered and burned must depend on whether they contain breeding beetles or are fit for their reception; because the adoption of useless measures, the destruction of material which will not again serve as a breeding place, is a waste of money.

Professor Riley, of the U.S. Department of Agriculture, writes to the Trinidad Committee (26): "I think you are perfectly correct in tracing "the increase of the *Xyleborus* to the discontinuance of the burn-"ing of the bagasse (as we call it in this country), and it seems probable "that the resumption of this custom will greatly decrease the number "of these beetles. I can hardly conceive it as possible that the insect "will oviposit by preference in healthy cane when it has a supply of "dead or dying vegetation at hand."

The Committee themselves say that dry megass contains no shot-borers, which I have myself observed to be the case; and it will be worth while examining megass to see if it really remains moist long enough to breed beetles for more than a short time after cutting. It will also be well to consider whether in countries like Jamaica and the sugar-growing districts of South America where the beetle exists without attacking the canes, the megass is treated in such a way as not to harbour them.

2. Cutting out and destroying canes diseased, or attacked by the *Xyleborus* or the larger borers.

If these can be utilised by passing through the mill so much the better. They should not be cut out and left till the beetles can complete a generation in them, or this treatment will be of little use.

3. Cutting the canes close so as to avoid stumps in which the insects will propagate.

4. Inspecting the surroundings of the fields to examine dead trees, branches or stumps for this insect, and destroying those, if any, containing them; for it is little use taking elaborate precautions to destroy rubbish, &c. in the fields if the beetles occur outside them and can fly in freely.

The measures referred to in this section are, notwithstanding possible objections to some of them, deserving of the most thorough trial.

22. The Protection of Standing Canes.

Miss Ormerod has recommended (19, 24) the application of kerosene and soft soap or carbolic acid to the outside of the standing canes.

Prof. d'Albuquerque writes (19): "In fields adjacent to such infested "fields in June and July, while the canes are still young, walk with a "pailful of emulsion of soft soap and kerosene recommended by Miss "Ormerod and a brush, and shake in passing a brushful over each "cane. Or to use instead the mixture of carbolic acid and water "recommended by the same authority."

I am sorry to have to dissent altogether from this advice, but I cannot conceive how the beetles, which attack the canes when they ripen, are to be kept off by wetting the plants in June and July with volatile insecticides, the effects of which would pass off perhaps in 24 hours, at most in a few days after application. Kerosene and carbolic acid are excellent remedies for destroying insects actually present or keeping off an attack which is taking place at the moment of use; but it is questionable whether the planters will care for the trouble and expense of daubing the canes from July to March with a bi-weekly coating of kerosene.

If applications of any sort are to be made to the canes to keep off the *Xyleborus*, a proceeding quite unsuited, in my opinion, on the ground of safety, economy, or effectiveness, they must be far more permanent than those recommended.

The non-volatile poisons, usually mineral salts, are too dangerous to be used (I have seen a reference to copper sulphate, of all things!), and I cannot at present suggest anything except perhaps thick muddy or clayey water which would serve as a mechanical protection to the part of the cane usually attacked.

At the same time it must be admitted that unlikely remedies sometimes achieve unexpected success, and if they do not, may lead to something more practical.

But far more important than the application of new remedies is it that the causes of these attacks shall be further investigated by thorough and painstaking researches.

However destructive *Xyleborus perforans* may be, if its destructiveness depends on some favouring circumstance, that must be sought out, and it, rather than the beetles, must be combated and overcome.

London, July 1892. Walter F. H. Blandford.

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16. 1892. . . . . Report to Central Agricultural Board, Trinidad. January 29th.

17. 1892. . . . . to a local newspaper, dated Trinidad, May 21st.

18. 1892. J. P. D'Albuquerque, Professor of Chemistry and Agriculture, Barbados. Report to the Committee of the Barbados Agricultural Society, dated 26th January 1892. (Reprinted in *Sugar-Cane*, April 1, pp. 212–214.)

19. 1892. . . . . letter printed in St. Vincent *Sentinel*, April 29th.

20. 1892. G. W. Smith, Curator of the Botanical Station, Grenada, to Royal Gardens, Kew, March 10th.

21. 1892. . . . . to Royal Gardens, Kew. March 31st.

22. 1892. Messrs. C. Tennant, Sons, & Co., to Royal Gardens, Kew. May 2. (With extract in letter from Trinidad.)

23. 1892. Miss E. A. Ormerod. Proceedings of Royal Agricultural Society, p. 32.

24. 1892. . . . . Letters reprinted in Barbados *Agricultural Gazette*, March, pp. 297–304.

25. 1892. T. D. A. Cockerell, *Bulletin* of the Botanical Department, Jamaica, April, pp. 2–7.

26. 1892. Draft Report of the Trinidad Field Naturalists' Club Committee upon the Small Sugar-Cane Borer. *Journal* of the Club, Vol. 1, No. 2, pp. 45–50. June, 1892.

Note.—Several of the above reports and letters have been reprinted in various West Indian journals. There is a short account of the shot-borer in "Insect Life" for June 1892, and a further and more detailed one is promised. The insect is there named *Xyleborus piceus*, Zimm.; but this is probably a slip for *pubescens*, Zimm. (vide § 3). The only *Xyleborus piceus* was described by Motschulsky from Ceylon.

EXPLANATION OF PLATE.

A. Sugar-Cane Moth-borer (*Chilo saccharalis*, Fabr.) after Howard.
   1. Male, upper side.
   2. Female, upper side.
   3. Larva.
   4. Pupa.

B. Weevil Cane-borer (*Sphenophorus sacchari*, Guild.).

C. Sugar-Cane Shot-borer (*Xyleborus perforans*, Woll.).
   1. Male, upper side.
   2. Female, upper side.
   3. Female in profile.
   4. Anterior leg of female.
   5. Antenna of female showing elongate basal joint (*scape*) bearing a 5-jointed shaft (*funiculus*) terminated by a somewhat hemispherical club whose flattened face indicates by concentric rings of hair the cup-shaped joints of which it is composed.

CCLV.—PARAGUAY INDIGO.

(*Eupatorium læve*, D.C.; E. tinctorium, *Pohl MSS.*)

In 1881 the Foreign Office communicated to Kew an extract from a Despatch from Mr. Edwin H. Egerton, C.B., Her Majesty's Chargé d'Affaires at Buenos Ayres respecting certain vegetable products of Paraguay. Amongst these was a dye plant, of which Mr. Egerton gave the following account :—

"Of dyes, the dye from the *Eupatorium tinctorium*, a shrub from the leaves of which is produced a blue, long used by the Indians, and very similar to, though perhaps a little darker than, indigo, but otherwise extremely good. A small sample of it lately sent to France brought 12 francs when the Indian indigo was sold for 15 francs.

"The Central American blue dyes have generally been beaten from the field by the Indian indigo. I am told, however, that this Paraguayan shrub has such singular fecundity and vigour that it can be stripped four times a year without injury to the plant. As it requires little care or cultivation this dye plant might some day compete in the European market with that of the Indian indigo."

From botanical specimens of this plant received from Mr. Egerton in 1885 Professor Oliver was able to express an opinion that "it was "identical with a plant sent by Balansa from Paraguay as an indigo-"producing plant called in Guarani *Urubu-retina* and placed with "*Eupatorium læve*, D.C. To this species it is certainly allied, if not "indeed a mere state. Pohl has left a manuscript name *E. tinctorium* "(folia tincturam cœruleam ei Indigofera Anilis similem præbent)". In the *Flora Brasiliensis*, vi., pt. 2, 352, Mr. J. G. Baker has reduced Pohl's name as a synonym under *Eupatorium læve*, D.C., the name here adopted for Mr. Egerton's plant. The material sent over to this country did not allow of a trial being made to test the yield and value of the indigo. Last year the subject was again revived.

Royal Gardens, Kew, to Foreign Office.

Sir, Royal Gardens, Kew, 15 April 1891.

I am desired by Mr. Thiselton-Dyer to inform you that in an extract from a Despatch from Her Majesty's Chargé d'Affaires at Buenos Ayres, dated 31st July 1881, communicated to this establishment in your letter of the 1st September of the same year, reference is made to a blue dye prepared from *Eupatorium tinctorium*, a Paraguayan shrub.

2. It is said that "this dye is a little darker than indigo, but other-"wise extremely good. A small sample of it lately sent to France "brought 12 francs when the Indian indigo was sold for 15 francs."

3. Nothing further appears to have been done to investigate this substance. Mr. Thiselton-Dyer has, however, recently been in communication with the Department of original research in dyeing at the Yorkshire College, Leeds, and he is informed that this Department is prepared to investigate the matter provided an adequate supply of material, consisting of the leaves of the plant, could be forwarded direct to Leeds for that purpose.

4. Mr. Thiselton-Dyer would recommend, with the approval of the Secretary of State, that the subject be brought to the notice of Her Majesty's Minister at Buenos Ayres, who may be disposed to assist in the investigation of an interesting subject.

I have, &c.
(Signed) D. Morris.

Sir Villiers Lister, K.C.M.G.,
Foreign Office, S.W.

In December last a case containing a supply of leaves was received at Kew and forwarded to Professor Hummel, of the Yorkshire College, Leeds. It may be mentioned that the leaves were in a dry condition, and thus they did not afford the best condition for being tested for indigo. The result is contained in the following report which has been obligingly communicated to this establishment.

The conclusion arrived at clearly shows that the leaves must be worked on the spot in a fresh state. There is undoubtedly indigo in the leaves, and the plant might be utilised locally for supporting an important indigo industry in the new world. The plant is singularly hardy, and, as suggested by Mr. Egerton, "it might some day compete "in the European market with Indian indigo."

Professor Hummel to Royal Gardens, Kew.

The Yorkshire College, Leeds,
Sir, 14 June 1892.

* * * *

With respect to the *Eupatorium tinctorium* leaves received some time ago, I find they yield an extremely small quantity of indigo, no doubt owing to the decomposition of the "indican" originally present. I sent a sample of the leaves to Dr. Schunck, who is our greatest authority on this subject, and he wrote me as follows:—

"The leaves certainly do contain indican but the quantity is very small. I tried several ways of obtaining, not indican, but the indigo representing it, from the leaves, but all the methods except one gave next to nothing. This method was as follows:—The pounded leaves separated from the stalks, &c. were stirred up with cold water and the extract after standing for some time was strained through calico. To the yellow extract a small quantity of sugar of lead solution was added, the dirty yellow precipitate was filtered off and to the yellow filtrate an excess of hydrochloric acid or a little nitric acid was added. On standing, indigo blue separated; this was filtered off and treated first with boiling water and then with caustic lye, then dried. In this way the enclosed specimens were obtained, each from 100 grains of leaves, No. 1 using HCl. and No. 2 using HNO_3. In my opinion the only way of ascertaining the value of the leaves for producing indigo is by working them up while fresh at the place where the plant grows."

I am, &c.
(Signed) J. J. Hummel.

The Director,
Royal Gardens, Kew.

CCLVI.—FAHAM TEA.

(*Angræcum fragrans*, Thouars.)

There are so few species of orchids possessing economic value, that the order as a whole is valued chiefly for the beauty and singularly diversified forms of its flowers. Amongst orchids yielding economic products, the most important are the Vanillas, of which *Vanilla planifolia*, a native of Mexico, is the species most commonly cultivated. The fruit of another American orchid, *Selenipedium chica*, according to Seemann (Bot. Herald, p. 215), "is highly esteemed as an aromatic by the "inhabitants of the Isthmus of Panama, and used for all purposes for "which real vanilla is commonly used." A few species of the genus *Orchis* yield from their bulbs a starchy mucilaginous substance known as Salep. The leaves of *Goodyera pubescens*, a North American orchid, have been used in the cure of scrofula. The roots of *Corallorhiza odontorhiza*, known as Coral or Crawley root, have a strong peculiar odour, and are used as a diaphoretic and sedative. The roots of the yellow Lady's Slipper or Moccasin flower (*Cypripedium pubescens*), also a native of North America, are used as a tonic and stimulant medicine, while a small epiphytical orchid, the subject of the present notice, a native of Mauritius and Réunion, yields an odoriferous principle from its leaves. This latter is *Angræcum fragrans*, Thouars, known locally under various names as Faham and Fahum, and specially interesting on account of the persistent vanilla-like odour of the leaves, which has led to its use as a tea in Bourbon or Réunion, the Mauritius, and even to some extent in France. The plant is epiphytical on trees in the forests of Réunion and Mauritius. It is perennial and produces a few narrow green leaves and fragrant white flowers. The flowering season is during the months of February and March. Plants of this species were received at Kew from Mr. John Horne, F.L.S., Director of the Botanical Gardens, Mauritius, in 1887. These flowered in this country in January 1890, and a figure was prepared for the *Botanical Magazine*, t. 7161 (1891).

The following note "on the odoriferous principle of the leaves of *Angræcum fragrans*" by M. Gobley in the *Chemical Gazette* is quoted in the *Gardeners' Chronicle*, 1850, pp. 599–600:—

"The leaves of Faham, known also by the name of Fahon or Fahum leaves, are imported from the Mauritius; they are obtained from a plant first described by Dupetit-Thouars under the name of *Angræcum fragrans*, belonging to the *Orchideæ*. Like many of the exotic orchids, the Faham is parasitic. It is a charming plant, and much sought after by the Asiatics on account of its fragrance. It is sufficient to touch the fresh leaves for the fingers to remain impregnated with the aroma. The dry leaves, which occur in commerce, have an odour which considerably resembles that of the Vanilla, belonging to the same family of plants. Alcohol and ether separate the aromatic principle; boiling water removes a slightly bitter principle and a mucilaginous substance, besides the aroma. In the country whence they are derived, and even in France, a very agreeable tea is prepared from them, which is used as a digestive, and even recommended in diseases of the respiratory organs. Mixed with ordinary tea, they impart to it an extremely agecable perfume."

Under the title of "orchid tea" a further account was given by Mr. J. R. Jackson, A.L.S., of the same plant in the *Gardeners' Chronicle*, 1866 (1), p. 315:—

"The plant yielding the new orchid tea is *Angræcum frágrans*, Thouars, an epiphytal orchid of the Island of Bourbon, where it is known and used by the natives under the name of 'Faham.' This word, once an obscure native name, is now, if we are to believe the enterprising French firm who has just introduced it, destined to become a 'household word,' for 'Faham' is the name under which it is now sold in Paris, and the word appears in large letters upon the boxes in which it is packed, as well as upon the circulars accompanying them. The headings of these circulars run as follows:—'Faham from the Isle of Réunion.' There is also a rough, but not at all a bad cut of the plant producing it. The circular itself begins by saying that tea proper has never been well received in France, owing to the wakefulness resulting from its use, which has caused many persons to reject it altogether, while many of those who do use it, drink it in default of a better substitute. Faham is not a new production. From time immemorial the natives of the islands of Réunion and Mauritius, though situated, as it were, at the very gates of China, have preferred it to tea; every traveller has partaken of their preference; George Sand eulogises it in the fine description which she gives to the Isle of Bourbon, an eulogy which was written years before the introduction of Faham into France was thought of. The difficulties experienced in the gathering and manufacture of Faham on a large scale, and its very high price, have alone prevented it from being imported into France. After many fruitless attempts, these obstacles have been overcome.

"Faham grows upon the high slopes of the Island of Réunion, in the midst of almost inaccessible forests. It possesses a taste differing greatly from that of tea, but is preferred by the majority of persons who have tasted it. It possesses an aroma of great delicacy, capable of being rendered more or less pungent, according to the quantity used, and it gives forth a most agreeable perfume; after being drunk it leaves a lasting fragrance in the mouth, and in a closed room the odour of it can be recognised long after. This beverage has the further advantage over tea, which requires to be drunk at the time of making, that it can be reserved for a future occasion if requisite, and may either be taken cold or made hot again. Milk, or spirits in small quantities, especially rum, serve to develop its aroma. Lastly, this valuable plant is made use of to flavour custards and ices, to which it communicates its delicate fragrance.

"To be taken as a warm beverage, the leaves and stalks should be placed in cold water, in about the proportion of one gramme to a teacup, more or less, as the consumer may desire it of a greater or less degree of strength. The water should be immediately made to boil for about the space of 10 minutes in the tea kettle or other closed vessel. It should then be emptied into the teapot or teacups, and sweetened accordingly."

A sample of this new kind of tea has recently been received at the Kew Museum; it was packed in a very neat, canister-shaped box, similar to those now sold in Paris. These boxes are of two sizes, the smaller containing material sufficient for making 50 cups of Faham, and sold at 2 f. 50 c., and the larger 105 cups, and sold at 5 f. Upon opening the box the perfume emitted was exceedingly powerful, and very similar to the Tonquin bean. The leaves, unlike those of tea, appear simply dried, not shrivelled by heat, but are as flat as we should find them in any herbarium. The absence of any artificial colouring matter, or roasting, accounts for the very light colour of the infusion.

In the Museum of the Royal Gardens at Kew are some cigars made of the leaves of *A. fragrans* simply rolled in a thin tobacco leaf. They are probably very agreeable smoking, but I am unable to say if this application is a common one in the Island of Bourbon, or whether these specimens are merely a curiosity.

CCLVII.—FALSE SISAL OF FLORIDA.

(*Agave decipiens*, Baker.)

In the *Kew Bulletin* for February last, pp. 21–40, a general account was given of the Sisal Hemp industry, and particulars were given of the distribution of Sisal Hemp plants in nearly every part of the world. In the description of the plants found in Florida it was pointed out that the bulk of these consisted of the best sort for fibre (*Agave rigida*, var. *sisalana*), in every respect similar to the plants now being so largely planted in the Bahamas, Turks Islands, Jamaica, and elsewhere. Amongst the Florida plants Mr. Charles Richards Dodge, an officer of the United States Department of Agriculture, found here and there some plants which were evidently not true Sisal. For instance, "at Juno, about "ten miles further south (from Jupiter), at the head of Lake Worth, "I found another fine nursery of perhaps a hundred thousand plants, the "property of Mr. A. M. Fields, who is quite enthusiastic on the subject. "Fully fifty per cent. of his plants are not *Agave sisalana*, however, "but a species which was subsequently met with at many points along "the east and west coasts as well as on the Keys—doubtless *Agave* "*mexicana*."* At the time this was quoted in the *Kew Bulletin* (p. 26) it was stated that probably this determination would require to be verified. Since that time abundant material has been received at Kew from Florida from Mr. Richards Dodge, and there is no doubt that the plant which he had provisionally taken to be *Agave mexicana*, and mentioned in his report under the name of "False Sisal," was an entirely new species. In a letter dated April 27, 1892, forwarding specimens, Mr. Richards Dodge states :—

"Department of Agriculture, Washington,
April 27, 1892.

"I have just received from Biscayne Bay, Southern Florida, some blossoms of my so-called 'false Sisal,' accompanied by mature leaves taken from the same plant. One of these I send you by mail to-day, the others being in a semi-decayed condition and unfit to send. This is the normal length of the leaves found throughout the Biscayne Bay region and along the line of Keys. Those at Lake Worth, which is very near to Jupiter, I found with leaves at least a foot longer, in rare instances two feet longer, though preserving the same characteristics. I send you with this a few blossoms, together with a sample of true Sisal hemp, and another of false Sisal for comparison with it. As you will see, one is a strong, good fibre, the other is not more than half as strong, and of different appearance."

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* Sisal Hemp Culture in the United States. Fibre Investigations. Report No 3, 1891, p. 41.

These and other specimens have enabled Mr. J. G. Baker, F.R.S., the Keeper of the Herbarium at Kew, to draw up the following description of the plant:—

Agave (Euagave) decipiens, Baker.

Caudice demum 3–4-pedali, foliis dense rosulatis ensiformibus rigidis demum 4-pedalibus utrinque levissimis viridibus infra medium ad apicem sensim angustatis, facie sæpissime concavis, spinâ terminali pungente breviter decurrente, aculeis marginalibus parvis atro-castaneis deltoideo-cuspidatis, floribus in paniculam amplam thyrsoideam dispositis, ovario oblongo, perianthii tubo brevi late infundibulari, lobis tubo duplo longioribus, staminibus longe exsertis, stylo staminibus demum æquilongo.

Hab. Florida, Biscayne Bay, and Lake Worth. For all the material from which the plant is described we are indebted to C. R. Dodge, Esq., the special agent for fibre investigations of the United States Department of Agriculture. It is the plant "supposed to be *A. mexicana*," figured on plates 7 and 8 of his report, No. 3, issued May 1891.

Caudex reaching a length of 3–4 feet, whilst *A. sisalana*, over the same area, remains nearly acaulescent. *Leaves* densely rosulate, very rigid, ensiform, reaching a length of 4 feet, broadest a little below the middle, where they reach 3½–4 inches, narrowed very gradually to the horny brown pungent point, which is ½–¾ in. long, and decurrent as a narrow brown-black line along the edge of the leaf for 3–4 inches, narrowed also to a point above the diluted base, where they are 2½ in. broad, very smooth and apple green on both surfaces, not distinctly glaucous even when young, usually very concave all down the face and convex on the back, rarely flat; marginal prickles moderately close, deltoid, cuspidate, brown-black, not more than a line long.

Peduncle with panicle about five times as long as the leaves. *Panicle* 8–10 feet long, with a rather flexuose axis, and usually single dense clusters of flowers terminating the laxly-disposed simple arcuate branches.

Flowers arranged in dense clusters. Ovary oblong, finally 2 in. long, ¾ in. diam. *Perianth* greenish-yellow, an inch long; tube broadly funnel-shaped; lobes complicate lanceolate from a dilated base, twice as long as the tube. *Stamens* 18–21 lines long, inserted at the middle of the perianth tube; anthers linear, ½ in. long. *Style* finally reaching to the top of the stamens.

Belongs to the section *Rigidæ* and nearly allied to *A. rigida* var. *A. elongata*, Jacobi, from which it differs by its longer caudex and concave-faced leaves, which are very smooth on both sides, and not at all glaucous even when young, broadest below the middle, and narrowed very gradually to the hard point, which is decurrent for a short distance as a narrow brown-black border. The fibre which it yields is very inferior in tenacity to that of *A. sisalana*. I cannot make out any material difference between the flowers of the two species. The name *decipiens* refers to the plant being confused so easily with the forms of *A. rigida*, of which the fibre is so much more valuable that it would lead to loss and disappointment if it were cultivated for economic use.

J. G. Baker.

CCLVIII.—VINE DISEASE IN GREECE.

The currants of commerce are obtained from the Black Corinth or Zante grape vine. This is a variety of the common vine, with stoneless or seedless fruit. The plant is chiefly cultivated on the mainland of Greece and the Ionian Islands, and the annual value of the exports amounts to about a million and a half sterling.

Latterly the plants yielding commercial currants at Pyrgos, on the west coast of Greece, have been attacked by disease, and Her Majesty's Vice-Consul in that district has furnished the following report, which has been obligingly communicated to Kew by the Foreign Office:—

FOREIGN OFFICE to ROYAL GARDENS, KEW.

SIR, Foreign Office, June 17, 1892.

I AM directed by the Secretary of State for Foreign Affairs to transmit to you, to be laid before the Director of the Royal Gardens, a report on the vine disease at Pyrgos in Greece.

I am, &c.

The Assistant Director, (Signed) JAMES W. LOWTHER.
Royal Gardens, Kew.

Enclosure.

REPORT of Mr. Vice-Consul FAUQUIER, of Pyrgos, on a Disease of the Currant Vines in his Vice-Consular District.

Yesterday I went on an inspecting tour to see if the complaints of the currant disease are, or are not, exaggerated. My impression is that there are localities that are literally devastated, not a bit of exaggeration, others to the extent of 50 to 60 per cent., and those that have suffered less have a damage of 10 to 20 per cent. It is, therefore, to be understood that the evil has spread more or less all over the district.

If it makes no further progress (but it shows no sign of abatement, and there is too much moisture in the atmosphere) the damage thus far done in Pyrgos and Olympia is very serious, probably one-third to one-half of the crop, and probably more, but of course one must be careful in quoting figures.

As to the damage being at least one-third of the crop, there can be no doubt whatever.

(Signed) CHARLES FAUQUIER,
Pyrgos, 6 June 1892. Vice-Consul.

CCLIX.—MISCELLANEOUS NOTES.

MR. WILLIAM TRUELOVE retired from the service of the Royal Gardens, Kew, on April 30th last, after serving 26 years as foreman of the Arboretum, a position which he filled with great credit to himself and satisfaction to his superior officers. Before coming to Kew Mr. Truelove had charge of the then famous Bicton Arboretum, and his selection

to fill the post from which he has retired, has been justified in every way. From small beginnings—the number of ligneous plants cultivated in the open air at Kew was comparatively very small 26 years ago—the Kew Arboretum has developed to a considerable extent; at the present moment it contains about 3,000 species and named varieties—excluding garden varieties of such plants as Roses, Rhododendrons, Hibiscus, &c.

The Superannuation Act of 1887 having practically abolished the pensions to which men in Mr. Truelove's position were formerly able to look forward, he was on retirement only entitled strictly to the gratuity of 47*l.* 10*s.* which the Treasury awarded him. But in consideration of his exceptional services the First Commissioner was pleased to make a special application on Mr. Truelove's behalf to the First Lord of the Treasury. This obtained for him a further grant, though it was expressly stipulated that this was not to be regarded as a precedent for the future. The Board recorded the award in the following minute :—

DIRECTOR OF KEW,
To inform Mr. Truelove.

In dispensing with his services the Board desire to record their appreciation of the diligence and skill which he has shown in the discharge of his duties during the period that he has been in their employ. It is to a large extent in recognition of this that the First Commissioner recommended, and that the First Lord of the Treasury has granted, an additional gratuity of 120*l.* from the Special Service Fund.

17th May 1892. H. W. P.

Mr. W. J. Bean succeeds Mr. Truelove as foreman in the ARBORETUM. Mr. Bean first entered the Kew service from the gardens of Belvoir Castle on April 2nd, 1883. He was not long before rising to the rank of sub-foreman, and on the retirement of Mr. Binder in 1888, Mr. Bean became foreman of the Temperate House.

Mr. Thomas Jones fills the post of foreman of the TEMPERATE HOUSE vacated by Mr. Bean. Mr. Jones came to Kew as gardener on January 2nd, 1888, from the Nurseries of Messrs. James Dickson & Sons, of Chester. In July 1889, he was promoted sub-foreman in the Palm House.

BORASSUS FLABELLIFORMIS.—Kew is indebted to His Highness the Gaekwar of Baroda for a healthy young specimen of this, the Palmyra Palm, which has lately been received and may now be seen in the Palm House. Hitherto all attempts to grow this palm to any size at Kew have failed, although we have now healthy seedlings which were raised from seeds presented by the Right Hon. Sir M. E. Grant-Duff, G.C.S.I., in 1886, when Governor of the Madras Presidency. The specimen from Baroda has a trunk 2 feet in diameter and 4½ feet in length, and although its roots perished on the journey, it is otherwise in good condition. It had been lifted and carefully packed by Mr. Henry, the Superintendent of the Baroda Gardens. We are also indebted to Mr. W. Goldring, who kindly interested himself in this matter whilst at Baroda, where he is engaged in laying out new Parks and Gardens for the Gaekwar.

A new house for Filmy Ferns has just been erected on the north side of the large Fernery (No. 2), and the plants removed from the old house (No. 3), which is to be replaced by one more suitably adapted for the cultivation of Temperate Ferns. The Filmy Fern House is 50 feet by 14 feet, with a central path and two cases running the full length of the house. The Cooper-Forster collection is now incorporated with the Kew plants, the whole forming an exceptionally rich collection of these delicate little ferns.

A very extensive and valuable series of products illustrating the varied uses of the Bamboo in Japan has recently been presented by Charles Holme, Esq., F.L.S. It has been arranged in two cases in Museum No. III., and shows at a glance both the ingenuity of the people in adapting this valuable arboreal grass to their daily wants, and the suitability of the bamboo stem to the purposes to which it is put.

This collection worthily supplements the large and interesting set of bamboo products from various tropical countries previously shown in the classified collection in Museum No. II.

Another interesting though temporary addition to Museum No. III. is a framed set of 21 large photographs representing views of tropical scenery and plants in the Island of Grenada, taken by R.V. Sherring, Esq., F.L.S., whilst investigating the Cryptogamic Flora of that Island for the West Indian Exploration Committee of the Royal Society and British Association. Mr. Sherring has deposited the collection on loan for a short time.

Mahogany in Fiji: Seeds of the valuable Mahogany tree have been distributed from Kew to all parts of the world. One of the latest recipients was the Colony of Fiji. In a letter received from the Curator of the Botanical Station at Suva in March last it is stated, that 700 plants had been raised from Kew seed, and several cases containing Mahogany plants had been forwarded to the district Magistrates in order to establish this valuable timber tree through the group. It is further mentioned that 150 plants had been put out in and near the garden, some of which were 12 to 14 feet in height. A good number was still on hand, but, of these, the Governor, Sir John Thurston, hoped to utilise many to plant along a new road proposed to be opened through the mountains.

A very remarkable Gouty-stemmed Balsam was lately figured and described in the *Botanical Magazine*, t. 7195, from the east coast of Sumatra, under the name of *Impatiens mirabilis*, Hook. f. The perennial stem is about 4 feet in height, and the thickness of a man's leg. It has large yellow flowers produced on short lateral racemes. There are several living plants in the Kew collection, one of which is in flower now (July 1892). The following additional information respecting this balsam has been forwarded to this establishment by its discoverer, Mr. Charles Curtis, Assistant-Superintendent of the Gardens and Forest Department, Straits Settlement, in a letter dated Penang, May 3rd, 1892:—"I have recently been to the Langkani Islands, where

" I obtained many interesting plants, a set of which has been put aside " for your herbarium. I saw some fine specimens of *Impatiens mirabilis*, " Hk. f. with stems 5 feet high, 22 inches in diameter at the base, and " with 20 or more branches, each having 2-3 expanded flowers and " numerous buds. It grows in places difficult of access, on sharp-pointed " limestone rocks that cut like knives. It appears to lose its leaves " entirely during the dry season, and was only just commencing its " growth when I was there last month."

In addition to the Vascular Cryptogams collected under the auspices of the West India Exploration Committee by Mr. R. V. Sherring, F.L.S., and described in the *Annals of Botany*, Vol. VI. No. 21, April, 1892, by Mr. J. G. Baker, F.R.S., his collections have yielded about thirty species of ORCHIDS FROM GRENADA, some of which are of considerable interest. These have now been determined by Mr. R. A. Rolfe, A.L.S. The orchids of Grenada appear not to have been systematically collected before. There is no record of species from that island in Grisebach's *Flora of the British West India Islands*, 1864, and only about three or four were represented in the Kew Herbarium. Mr. Sherring's collections therefore enable us to arrive at a tolerably good idea of the distribution of orchids in the island. A species of *Brachionidium*, a genus not hitherto represented in the West Indian flora, is probably new, as also species of *Scaphyglottis* and *Cranichis*. *Hexisia reflexa*, *Pleurothallis pruinosa*, and *Ornithocephalus gladiatus* have not hitherto been found in the smaller islands, the recorded specimens being chiefly from Jamaica and Trinidad. *Oncidium luridum*, one of the most striking of West Indian orchids, with spikes 5 or 6 feet long, is established also as a Grenada plant. *Dichœa hystricina* has not been found before except in Cuba by Wright and Eggers. *Xylobium* (*Maxillaria pallidiflora*) was recorded before only from St. Vincent, and *Elleanthus lepidus* is new to the West Indian flora. The remaining species are found in many islands, such as Jamaica and Dominica, but their occurrence still further south is a point of some interest. Of Mr. Sherring's general collection a number of Phanerogams have still to be worked out.

Mr. J. F. Duthie, F.L.S., Director of the Botanical Department, Northern Indies, writes as follows from Saharunpur, dated 27th February, 1892 :—

" It may interest you to hear, should you not already have been informed, that SUGAR CANE has been FLOWERING freely this season in various parts of India. In this district, flowers have been abundantly produced as well as in those of Etáwah and Cawnpore; and a similar report comes from the Poona district of the Bombay Presidency. I have made arrangements for securing as much seed as possible for raising stock ; and a note of mine in the 'Pioneer' newspaper will no doubt induce others, who have an interest in sugar cane cultivation, to do the same.

" I find on inquiry, that seven years ago a few flowering specimens of sugar cane were observed in this district ; but it is 22 years since such an abundant harvest of flowers has been known as that of this year. The native cultivators are much exercised in their minds over this sudden and unusual development, and look upon it as a sure sign of some impending calamity. In this district, none of the 'paunda' or thick-stemmed kinds, used for chewing, have flowered this year ; but of

the hard-stemmed varieties from which sugar is made, the following have flowered: Kannar, Lábri, Ghorruh. I am sending by this week's mail flowering specimens of each of the above, and next week I will send you some seed."

The sugar cane seed promised by Mr. Duthie, was duly received at Kew. It was sown on two occasions and carefully watched, but none of it germinated. It is quite possible that in India, as in the West Indies and Java, some varieties of sugar cane may produce seed, but the experience at Kew with Indian seed appears to confirm the results given in the Annual Report of Government Botanical Gardens, Saharunpur, for the year 1891, p. 10, and is purely of a negative character.

The recent hurricane at MAURITIUS appears to have been equally destructive to vegetable life, and the beautiful Botanical Gardens in the island have been almost completely destroyed. Photographs of different portions of these gardens taken immediately after the cyclone show nothing but heaps of wreckage, where once majestic palms, feathery tree ferns, and lovely orchids flourished only a few hours before. Mr. William Scott, the Acting Director, writes as follows on the 12th May last:—

"Since I wrote to you last we have had a sad disaster here. A cyclone of terriffic force swept over the island on the 29th April, and almost laid it in complete ruins. Hundreds of people have been killed and wounded, and thousands are homeless. One-third of the town of Port Louis is a heap of ruins. The sugar canes have been levelled and their leaves thrashed into fibre. The Gardens at Pamplemousses are a complete wreck, the oldest and finest trees have been uprooted, and the trees that are still standing are reduced to bare poles. The fruit trees have been so smashed up that I can hardly recognise them. I have sent you a photo of my house showing a little of the wreck. I shall send you some more when I can get them. In some parts the wreckage is piled up nine feet high, and it will be months before we can get it cleared away."

The following further information respecting the Sisal Hemp or Pita cultivation in the Bahamas is given in the Governor's Report on the Blue Book for the year 1891 (Colonial Reports, No. 44, 1892):—

"Fibre cultivation makes very satisfactory progress, and there are now about 8,000 acres planted out. At least 6,000 acres will be added to this area in 1892. A larger addition would be made but that the supply of plants of the requisite growth is yet limited. It is now ascertained that it is not advisable to transplant from the nurseries until they are at least one year old, and have attained to a length of 12 or 15 inches. The nurseries, however, are in full operation, and I believe that after the present year the supply of plants will be equal to any supposable demand. The adoption of the limit which restricts Crown allotments for 10 years to 100,000 acres, assures present investors against risk of over-production in the near future at least. The export from early plantings has now begun, and will be about 150 to 200 tons in 1892, and this will thereafter be an increasing quantity, but a careful estimate shows that it will not reach beyond 14,000 to 15,000 tons up to the year 1900. The subsequent advance will be much more rapid, but in no reasonable view of the circumstances can the export from the Colony have a marked effect on the market for many years to come. It is now ascertained that, with plants of fair growth, four years is the

longest time for the maturing of the plant, and it then yields an annual crop, without further care, for 12 or 14 years. I do not approve of forcing the crop, and immature cuttings are to be specially deprecated. The fibre is at its best after due time has been given for its growth, and unwise methods will be carefully dealt with by the Government in the highest interests of the Colony. There is much yet to be learned in connexion with this enterprise, but it is satisfactory to know that, with our present imperfect knowledge, no serious mistakes have been fallen into. Experience will no doubt lead to a lessened expense of cultivation, especially in the matter of weeding that has hitherto been a large item, but in which it now appears a reduction may be made. The highly important question of labour is well guarded, and the whole quantity of one hundred thousand acres may be brought into cultivation without strain on our present resources. The plant, being confessedly the best of any known growth, a demand from abroad has set in, and, though there are well considered doubts of its successful growth in some places where an attempt to cultivate the plant is being made, there seems no reason why any amount of competitive industry should be encouraged, and for this and other reasons the Act passed three years ago, to prohibit the export of plants, has now been extended for five years more. The available supply at present is not more than is required for the operations in the Colony, which would be hampered by outside demand, and the progress of the Colony be consequently retarded. It would be difficult to assign a limit to the future advance of the Colony from the growth of this remarkable industry. Though the land provisionally assigned to fibre cultivation (one hundred thousand acres) will in time yield 50,000 tons there seems no reason why even this great result should bar the extension of the area of production, if the markets of the time shall admit of its profitable disposal. It is generally thought that, from the excellence of the fibre, it will find its way into other fields for its use besides rope-making, and recent experiments prove that it takes a dye readily, indicating its adaptability to certain fabrics, and to some extension of demand on this account. There is the further ground for the probably strong place for Bahamas hemp in the future, that it can be produced more cheaply than any known fibre of equal value, and it may be inferred that it will hold its own at least against the influence of any probable competition with which it may have to contend."